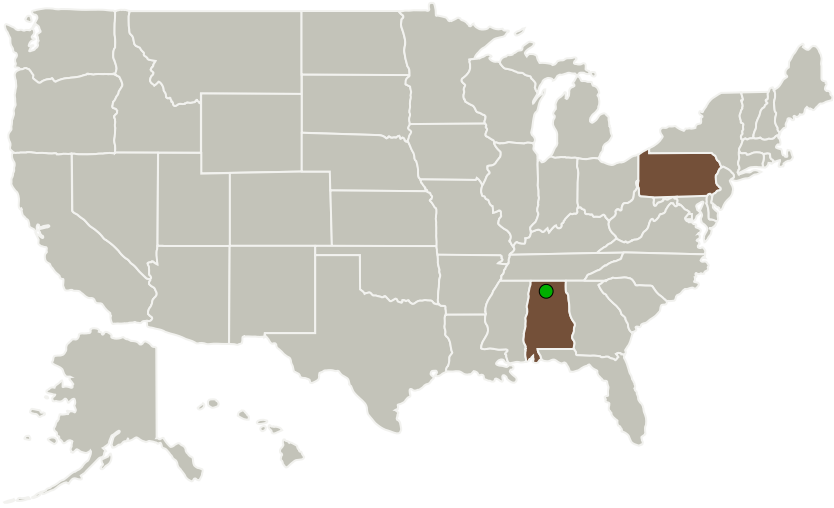
Alternative Fabrication Designs for Carbon-Carbon (C-C) Nozzle Extensions, Phase I

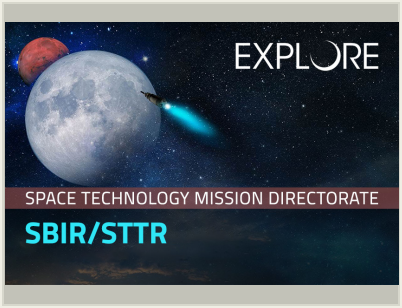
Completed Technology Project (2012 - 2012)

Project Introduction

In order for carbon-carbon nozzle extensions and exit cones to serve as practical, low cost components for future Earth-to-Orbit propulsion systems, it is necessary to develop alternative fabrication methods coupled with proven design and analysis tools. Two-dimensional (2D) C-C components are typically less expensive and potentially lower weight than C-C parts fabricated using 3D woven preforms. One typical 2D C-C fabrication method uses a tape-wrapping technique in which a bias-ply C/Ph tape is wrapped over a mandrel, cured, carbonized, and graphitized to form a carbon-carbon part. Tape-wrapping has been applied successfully to the development of erosion-resistant carbon-carbon exit cones. An alternative fabrication technique is to replace the flat 2D lay-ups with an involute construction. The involute plies spiral from the inner to outer diameter of the carbon-carbon part providing through-thickness reinforcement to reduce the potential for delaminations. In addition, each ply extends from the forward to the aft end of the part, increasing its axial strength considerably. The overall objective of this program is to design and demonstrate an alternative fabrication technique of nozzle extensions and exit cones on Earth-to-Orbit (ETO) propulsion systems. The Phase I program will be performed by a team of MR&D and ATK Aerospace Systems. The MR&D team is uniquely suited to perform the proposed effort because of previous experience on developing alternative fabrication methods of high-temperature C-C components such as exit cones and aeroshells. MR&D will manage the program, develop the processing and operational models, and design the C-C subcomponents to be fabricated. ATK Aerospace Systems will provide guidance and information as well as fabricate the C-C subcomponents.

Primary U.S. Work Locations and Key Partners





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Organizations Performing Work	Role	Type	Location
Materials Research and Design, Inc.	Lead Organization	Industry	Wayne, Pennsylvania
Marshall Space Flight Center(MSFC)	Supporting Organization	NASA Center	Huntsville, Alabama

Primary U.S. Work Locations	
Alabama	Pennsylvania

Project Transitions

February 2012: Project Start

August 2012: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/137992)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Materials Research and Design, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

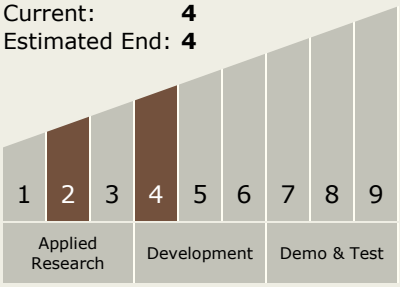
Carlos Torrez

Principal Investigator:

Leslie Weller

Technology Maturity (TRL)

Start: **2**
Current: **4**
Estimated End: **4**



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Technology Areas

Primary:

- TX01 Propulsion Systems
  - TX01.1 Chemical Space Propulsion
    - TX01.1.3 Cryogenic

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System